

What is claimed is:

1. An image processing apparatus for finding reflectivity based on a BRDF model expressing a ratio of reflection of light incident upon one point of a surface of an object to be drawn at the object surface,
5 comprising,

an operation means for calculating said reflectivity based on a BRDF model calculated by a quadratic-form matrix expression including a vector
10 comprised of a light source direction vector, a viewpoint direction vector, and a normal direction vector and a matrix determining the characteristics of the BRDF model.

2. An image processing apparatus as set forth in claim 1, wherein said vector comprised of the light
15 source direction, the viewpoint direction, and the normal direction is either of a three-dimensional vector expressing directions, a quaternion, and a pole coordinate.

3. An image processing apparatus as set forth in
20 claim 1, wherein said vector comprised of the light source direction, the viewpoint direction, and the normal direction is obtained by regressing the order by using an appropriate linear conversion.

4. An image processing apparatus as set forth in
25 claim 1, wherein said vector comprised of the light

source direction, the viewpoint direction, and the normal direction is obtained by converting these vectors by any elementary operation, table reference, or combination of the same.

5 5. An image processing apparatus as set forth in claim 1, wherein said operation means divides the matrix determining the characteristics of the BRDF model calculated by the quadratic-form matrix expression into sub matrixes and performs operation for evaluation using
10 a polynomial comprised of a quadratic form of the divided sub matrixes.

 6. An image processing apparatus as set forth in claim 1, wherein said operation means calculates a quadratic form by the procedure of multiplying the matrix
15 and vectors, then multiplying the vectors with each other.

 7. An image processing apparatus as set forth in claim 1; wherein said operation means combines evaluation results of one or more of said BRDF models by selectively using addition/subtraction, multiplication, division,
20 cumulative multiplication, and the quadratic form.

 8. An image processing apparatus as set forth in claim 1, wherein said operation means has a composite operation unit for calculating said BRDF model having two operation modes of a matrix operation equation comprised
25 of two different vectors and a sum of the quadratic-form

matrix including a triangle matrix and vector multiplication.

9. An image processing apparatus as set forth in claim 1, wherein said operation means gives the matrix
5 determining the characteristics of said BRDF model using a texture map.

10. An image processing apparatus as set forth in claim 1, wherein said operation means interpolates elements of the matrix determining the characteristics of
10 the BRDF model based on MIPMAP processing including predetermined filtering.

11. An image processing apparatus as set forth in claim 1, wherein said operation means refers to the matrix determining the characteristics of the BRDF model
15 from an indexed table.

12. An image processing apparatus as set forth in claim 1, wherein said operation means obtains the matrix determining the characteristics of the BRDF model by solving an equation comprised of a plurality of
20 polynomials obtained by entering a plurality of BRDF raw data given in advance into said BRDF model.

13. An image processing apparatus as set forth in claim 1, wherein said operation means forms the matrix determining the characteristics of the BRDF model from
25 the parameters of a polynomial texture map by a

correspondence obtained by assuming that a diffuse reflectivity distribution corresponding to the light source direction is the same as a specular reflectivity distribution corresponding to a half vector direction.

- 5 14. An image processing method for finding reflectivity based on a BRDF model expressing a ratio of reflection of light incident upon one point of a surface of a generated object at the object surface, comprising calculating said reflectivity based on a BRDF model
- 10 calculated by a quadratic-form matrix expression including a vector comprised of a light source direction vector, a viewpoint direction vector, and a normal direction vector and a matrix determining the characteristics of the BRDF model.
- 15 15. An image processing method as set forth in claim 14, wherein said vector comprised of the light source direction, the viewpoint direction, and the normal direction is either of a three-dimensional vector expressing directions, a quaternion, and a pole
- 20 coordinate.
16. An image processing method as set forth in claim 14, wherein said vector comprised of the light source direction, the viewpoint direction, and the normal direction is obtained by regressing the order by using an
- 25 appropriate linear conversion.

17. An image processing method as set forth in claim 14, wherein said vector comprised of the light source direction, the viewpoint direction, and the normal direction is obtained by converting these vectors by any elementary operation, table reference, or combination of the same.

18. An image processing method as set forth in claim 14, comprising dividing the matrix determining the characteristics of the BRDF model calculated by the quadratic-form matrix expression into sub matrixes and performing operation for evaluation using a polynomial comprised of a quadratic form of the divided sub matrixes.

19. An image processing method as set forth in claim 14, wherein said quadratic form performs calculation by the procedure of multiplying the matrix and vectors, then multiplying the vectors with each other.

20. An image processing method as set forth in claim 14, comprising combining evaluation results of one or more of said BRDF models by selectively using addition/subtraction, multiplication, division, cumulative multiplication, and the quadratic form.

21. An image processing method as set forth in claim 14, comprising calculating said BRDF model by a composite operator having two operation modes of a matrix operation equation comprised of two different vectors and

a sum of the quadratic-form matrix including a triangle matrix and vector multiplication.

22. An image processing method as set forth in claim 14, comprising giving the matrix determining the characteristics of said BRDF model by using a texture map.

23. An image processing method as set forth in claim 14, comprising interpolating elements of the matrix determining the characteristics of the BRDF model based on MIPMAP processing including predetermined filtering.

24. An image processing method as set forth in claim 14, comprising referring to the matrix determining the characteristics of the BRDF model from an indexed table.

25. An image processing method as set forth in claim 14, comprising obtaining the matrix determining the characteristics of the BRDF model by solving an equation comprised of a plurality of polynomials obtained by entering a plurality of BRDF raw data given in advance into said BRDF model.

26. An image processing method as set forth in claim 14, comprising forming the matrix determining the characteristics of the BRDF model from the parameters of a polynomial texture map by a correspondence obtained by assuming that a diffuse reflectivity distribution corresponding to the light source direction is the same

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as a specular reflectivity distribution corresponding to
a half vector direction.